Panpan (Priscilla) Zhou

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Research Interests

My research interests include: modeling and control of networked multi-agent robotics & autonomous systems, optimization, game theory, reinforcement learning, large language model

- I have extensive practical experience with **unmanned aerial vehicles (UAVs) and unmanned ground vehicles (UGVs)**.
- I have been involved in a number of projects on control of UAVs and UGVs, for instance, **Advanced Motion Planning Techniques for the Cooperation of Multi-agent Systems**, and **Collaborative Search and Pursuit-evasion for Unmanned Systems in Cluttered Environments**.
- Completing these projects requires algorithm design, software implementation, hardware construction, flight experiments, and certainly team work.

Work Experience

Digital Futures Postdoctoral Fellow (under Postdoctoral Fellowship) *April 2023 – present*
Digital Futures, KTH Royal Institute of Technology, Sweden

Supervisors: Prof. Xiaoming Hu, Department of Mathematics
& Prof. Bo Wahlberg, Division of Decision and Control Systems

- **I, as the main applicant, applied for the Postdoctoral Fellowship**
- Contributed to research about **modeling and control of multi-agent systems**, optimization, game theory, and security of **autonomous systems**
- Contributed to **writing proposals for projects**
- Have supervised 10 undergraduate students and two master students to complete their thesis
- Are guiding two junior PhD students

Postdoctoral Fellow *Nov. 2021 – April 2023*
The Chinese University of Hong Kong (CUHK), Hong Kong

Supervisor: Prof. Ben M. Chen, Department of Mechanical and Automation Engineering

- Led the Unmanned Systems Research Group
- Contributed to research about the stability control, **distributed cooperative control, optimal control, safety control, and motion planning of multi-agent systems**
- Conducted experiments with autonomous systems, especially UAVs and UGVs to verify algorithms
- Contributed to **writing proposals for projects**

Education

Ph.D., Department of Mechanical and Automation Engineering *Aug. 2017 – Nov. 2021*
The Chinese University of Hong Kong (CUHK), Hong Kong
Supervisor: Prof. Ben M. Chen
Thesis: Distributed Coordination Control of Multi-agent Systems with Actuator Limitation

B.Eng., Faculty of Automation *Sep. 2013 – Jun. 2017*
Northwestern Polytechnical University, Xi'An, China
GPA: 4.6/5.0; Rank: 1/63

Research Grants

- **Co-PI**, **Collaborative Search and Pursuit-evasion for Unmanned Systems in Cluttered Environments**, University Grants Committee, Hong Kong, 1,382,623 HKD, 2023-2025
- **KTH Digital Futures Postdoctoral Fellowship (Success rate: 4%)**, **Control and security of autonomous systems**, 2,000,000SEK, April 2023-March 2025
- **Advanced Motion Planning Techniques for the Cooperation of Multi-agent Systems**, University Grants Committee, Hong Kong
- **Human-in-the-loop Control of Multi-agent Autonomous Systems via Hybrid Games**, Digital Futures, KTH

Publications

No. of publications: 16 papers in renowned journals, 8 conference papers, and 1 book chapter.
My research focuses on the **distributed collaborative and non-cooperative control of multi-agent robotics and autonomous systems**, using optimization, game approaches, and learning methods.

Journal Articles

1. Distributed collaborative control of multi-robot systems with constraints (primarily during PhD)
Real-world physical systems inherently impose **constraints on actuators**, necessitating the development of **advanced control strategies for connected multi-agent systems** that ensure stability, optimality, and feasibility during task execution.

In this area, I have conducted a systematic investigation of **state estimation and coordination control methodologies across a wide range of system dynamics**, including UAVs [J10], marine surface [J11], robot manipulators and spacecraft [J13], general linear systems [J15], and heterogeneous systems [J14][J12][J9]. The *challenges* lie in the **coupling design of distributed observers and nonlinear controllers** with guaranteeing the stability of the closed-loop system and convergence of the actuator rate to the desired value. The convergence and stability guarantees established through these research efforts provide a strong theoretical foundation for the design of algorithms deployed in complex environments [J1], as the controllers are **more efficient in real-time computation**.

[J16] Y. Xu (guidance), **P. Zhou**, L. Wang, and X. Hu, 'Optimal intrinsic formation using exogenous systems,' accepted by *Science China-Information Sciences* **(Q1)**. Available at http://arxiv.org/abs/2503.13359.

[J15] **P. Zhou**, B. Wahlberg, and X. Hu, 'Optimal solutions for formation control of high-order integrators,' in preparation to be submitted to *Automatica* **(Q1)**.

[J14] **P. Zhou**, and B. M. Chen, 'Semi-global leader-following output consensus of discrete-time heterogeneous linear systems subject to actuator position and rate saturation,' *IEEE Transactions on Automatic Control* **(Q1)**, 68(2), pp. 1231-1236, 2024. https://doi.org/10.1109/TAC.2022.3216977.

[J13] **P. Zhou**, and B. M. Chen, 'Formation-containment control of Euler-Lagrange systems of leaders with bounded unknown inputs,' *IEEE Transactions on Cybernetics* **(Q1)**, 52(7), pp. 6342-6353, 2022. https://doi.org/10.1109/TCYB.2020.3034931.

[J12] **P. Zhou**, and B. M. Chen, 'Semi-global leader–following output consensus of heterogeneous systems with all agents subject to input saturation,' *International Journal of Robust and Nonlinear Control* **(Q1)**, 32, pp. 4648-4664, 2022. https://onlinelibrary.wiley.com/doi/pdf/10.1002/rnc.6045.

[J11] **P. Zhou**, X. Hu, and Y. Dong, 'Adaptive output observer for a non-autonomous leader system over periodic switching topologies and its applications to the formation control of offshore vessels,' *International Journal of Robust and Nonlinear Control* **(Q1)**, 33, pp. 9433-9449, 2023. https://doi.org/10.1002/rnc.6859.

[J10] **P. Zhou**, and B. M. Chen, 'Semi-global leader-following consensus-based formation flight of unmanned aerial vehicles,' *Chinese Journal of Aeronautics* **(Q1)**, 35(1), pp. 31-43, 2022. https://doi.org/10.1016/j.cja.2021.02.013.
Experiment video:
https://www.bilibili.com/video/BV1KL411J7Z9/?vd_source=7aab7ee2af9e6f8149872e2749f3a757
and https://www.bilibili.com/video/BV1xg411j7qZ/?vd_source=7aab7ee2af9e6f8149872e2749f3a757

[J9] **P. Zhou**, and B. M. Chen, 'Semi-global leader-following output consensus of heterogeneous systems subject to actuator position and rate saturation,' *Autonomous Intelligent Systems*, 1(8), pp. 1-13, 2021. https://link.springer.com/article/10.1007/s43684-021-00008-w.

2. Distributed non-cooperative control for robotic and autonomous systems (primarily during Postdoc)

In addition to cooperation, autonomous systems often interact in competitive ways in real-world applications. Understanding these interactions is crucial to improving the robustness and reliability of robotic and autonomous systems. In this area, my research focuses on the non-cooperative control of autonomous systems by developing advanced nature-inspired **pursuit frameworks for mobile robots** [J8] as well as distributed game-theoretic strategies for **multi-agent target fencing and capture control** [J3]–[J7]. The pursuit algorithms, integrated with target detection and motion estimation techniques, together constitute a more comprehensive framework for autonomous systems.

[J8] **P. Zhou**, S. Li (guidance), B. Wahlberg, and X. Hu, 'Nature-inspired dynamic control for pursuit-evasion of robots,' *Automatica* **(Q1)**, 183, 112629.
Available at http://arxiv.org/abs/2410.16829
Video: https://youtu.be/VC9oyULhnlw

[J7] **P. Zhou**, Y. Xu, B. Wahlberg, and X. Hu, 'A differential game approach to intrinsic encirclement control,' Revised for *Automatica* **(Q1)** as **(regular paper)**.
Available at http://arxiv.org/abs/2502.19933

[J6] **P. Zhou**, B. Wahlberg, and X. Hu, 'A differential game approach to encirclement control of high-order integrators,' in preparation to be submitted to *Automatica* **(Q1)**

[J5] Y. Xu (guidance), **P. Zhou**, L. Wang, Z. Liu, and X. Hu, 'Contest for system observability as an infinitely repeated game,' accepted by *Journal of Systems Science and Complexity*.
Available at https://doi.org/10.48550/arXiv.2306.13570

[J4] **P. Zhou**, and B. M. Chen, 'Distributed optimal solutions for multi-agent pursuit-evasion games for capture and formation control,' *IEEE Transactions on Industrial Electronics* **(Q1)**, 71(5), pp. 5224-5234, 2024. https://doi.org/10.1109/TIE.2023.3283684.
Experiment video: https://www.youtube.com/watch?v=uM_U1lQLLLU

[J3] **P. Zhou**, Y. Xu, X. Hu, and B. Wahlberg, 'Distributed strategies for pursuit-evasion of high-order integrators,' *Autonomous Intelligent Systems*, 4(1), pp. 1-13, 2024. https://doi.org/10.1007/s43684-024-00085-7.

3. Trajectory planning and control for robotic systems in complex environments (during PhD and Postdoc)

In this area, my research focuses on the control of multi-agent systems operating in complex environments, with explicit consideration of **physical constraints, inter-agent collision avoidance and obstacle avoidance**. The proposed approaches ensure that a team of autonomous systems can navigate **safely through cluttered environments** while dynamically adapting their formation configurations to successfully traverse dead zones, narrow corridors, and other challenging scenarios. In the near future, I plan to generalize the methods for nonconvex obstacles which are commonly seen in space environments, marine domains, and disaster-stricken areas.

[J2] X. Wei, J. Li, **P. Zhou**, X. Fang, H. Liu, 'Swarm trajectory planning using dynamic corridors for dead zone avoidance,' accepted by *Unmanned Systems*.

[J13] **P. Zhou**, and B. M. Chen, 'Formation-containment control of Euler-Lagrange systems of leaders with bounded unknown inputs,' *IEEE Transactions on Cybernetics* **(Q1)**, 52(7), pp. 6342-6353, 2022. https://doi.org/10.1109/TCYB.2020.3034931.

[J1] **P. Zhou**, S. Lai, J. Cui, and B. M. Chen, 'Formation control of unmanned rotorcraft systems with state constraints and inter-agent collision avoidance,' *Autonomous Intelligent Systems*, 3(1), pp. 1-12, 2023. https://link.springer.com/article/10.1007/s43684-023-00049-3.
Experiment video:
https://www.bilibili.com/video/BV1qp4y147nG/?vd_source=7aab7ee2af9e6f8149872e2749f3a757

Conference Papers

[C1] **P. Zhou**, X. Hu, B. Wahlberg, 'Distributed strategies for pursuit-evasion of high-order integrators,' Proceedings of the 18th IEEE International Conference on Control & Automation (ICCA), Reykjavík, Iceland, June 18-21, 2024

[C2] **P. Zhou**, and B. M. Chen, 'Distributed optimal solutions for multiagent pursuit-evasion games,' Proceeding of the 62nd IEEE Conference on Decision and Control (CDC), Singapore, December 13-15, 2023

[C3] **P. Zhou**, S. Lai, J. Cui, and B. M. Chen, 'Formation control of unmanned rotorcraft systems with state constraints and inter-agent collision avoidance,' Proceeding of the 17th International Conference on Control & Automation (ICCA), Naples, Italy, June 27-30, 2022

[C4] **P. Zhou**, 'Distributed observer for a non-autonomous leader over jointly connected switching networks,' Proceeding of the 41st Chinese Control Conference (CCC), Hefei, China, July 25-27, 2022

[C5] **P. Zhou**, and B. M. Chen, 'Semi-global leader-following output consensus of heterogeneous systems with position and rate-limited actuators via state feedback,' Proceedings of the 40th Chinese Control Conference, Shanghai, China, July 26-28, 2021. **This paper was in the Guan-Zhaozhi Award-Finalist (top3).**

[C6] **P. Zhou**, and B. M. Chen, 'Semi-global leader-following output consensus of discrete-time heterogeneous linear systems with position and rate-limited actuators via state feedback,' Proceedings of the 40th Chinese Control Conference, Shanghai, China, July 26-28, 2021. **This paper was awarded the Young Author Prize by the IEEE Control System Society.**

[C7] **P. Zhou**, and B. M. Chen, 'Output formation-containment control of multiple agents with leaders of unknown inputs over switching topologies,' Proceedings of the 16th IEEE International Conference on Control & Automation (ICCA), Sapparo, Hokkaido, Japan, October 9–11, 2020

[C8] **P. Zhou**, and B. M. Chen, 'Formation control of Euler-Lagrange systems of leaders with bounded unknown inputs,' Proceeding of the 2020 IFAC World Congress (IFAC), Berlin, Germany, July 12-17, 2020

Book Chapter

[B1] Leader-following output consensus of discrete-time heterogeneous systems
In *Complex Systems: Spanning Control and Computational Cybernetics* (Dedicated to Professor Georgi M. Dimirovski on his 80th Anniversary)
Panpan Zhou, and Ben M. Chen, Edited by Peng Shi, Jovan Stefanovski, and Janusz Kacprzyk
Springer Nature Series on Studies in Systems, Decision and Control, Springer, London, 2022

Selected Honors

Future Digital Leaders 2023 *Oct. 2023*
Digital Futures, KTH

Young Author Prize *July 2021*
The IEEE Control Systems Society, at the 40th Chinese Control Conference

Guan Zhao-zhi Award-Finalist *July 2021*
The 40th Chinese Control Conference

CUHK Ph.D Scholarship, Hong Kong *2017- 2021*

National Scholarship of China (0.2%) *Nov. 2015*
Ministry of Finance and Education of China

National Encouragement Scholarship (1.8%) *Nov. 2015*
Ministry of Finance of China

First Class Prize at the International Mathematical Contest in Modeling (MCM) *2015*

Teaching Experience

At both KTH and CUHK, I served as a teaching assistant of the following courses. I participated in designing the course content, was responsible for some of the lessons, exercise, homework and exam grading, leading the lab experiments, and offering office hour to answer questions.

I received positive feedback from student, such as '*I attended the exercises held by Panpan and I thought she was really good, it was unfortunate that she did not have any exercises at the end. I thought she had a very nice structure to her exercises and explained things very pedagogically*'.

- KTH SF2863 Systems Engineering
  Time: Oct. 2023-Dec. 2023 Student level: undergraduate student No. of students: 200
  No. of hours: 16 Responsible teacher: Prof. Per Enqvist
  Course focus: classical operations analysis and mathematical methods to analyze and optimize the operation of various systems.
  I was part of the teaching team as a teaching assistant, responsible for part of the teaching, exercise class, homework and exam grading, and answering questions in office hours. I received positive feedback from students

- CUHK ENGG 5403 Linear System Theory and Design
  Time: Jan.-May 2019 & Jan.-May 2020 Student level: graduate student No. of students: 50
  No. of hours: 24 Responsible teacher: Prof. Ben M. Chen
  Course focus: stability of systems, controllability and observability, minimal realization, state feedback and state estimators, pole placement, optimal control, model predictive control
  I participated in designing the course content and supervising lab sessions. During the lab sessions, students engaged in **assembling UAV platforms and indoor UAV flight experiments**. As a teaching assistant, I supported students using simulation tools such as MATLAB/Simulink for control and robotics-related coursework.

- CUHK MAEG 3050 Introduction to Control System
  Time: Sep.-Dec. 2017 & Sep.-Dec. 2018 Student level: undergraduate student No. of students: 150
  No. of hours: 24 Responsible teacher: Yunjian Xu
  Course focus: mathematical modelling and linear approximation of engineering systems, Laplace transform, state space model, transfer function and block diagram representation, characteristics of feedback systems, performance specifications, root locus design, frequency response design, Nyquist criterion, utilization of computer-aided analysis and design software
  As a teaching assistant, my responsibilities include leading tutorial classes, preparing homework solutions, grading homework and exams, and setting office hours. I also led the **lab sessions** for proof of additivity, shift invariance, and Static linearity of linear systems.

- CUHK ENGG 2420D Complex Analysis and Differential Equations
  Time: Sep. 2019-Dec. 2019 Student level: undergraduate student No. of students: 150
  No. of hours: 16 Responsible teacher: Thierry Blu
  Course focus: complex numbers, complex functions, complex integrals
  My responsibilities include leading tutorial classes, preparing homework solutions, grading homework and exams, and setting office hours.

- CUHK ENGG 1410C Linear Algebra and Vector Calculus for Engineers
  Time: Jan. 2018-May 2018 Student level: undergraduate student No. of students: 50
  No. of hours: 16 Responsible teacher: Yufei Tao
  Course focus: matrices, inverses, special matrices; vector spaces, basis and dimension, linear independence, rank, determinants; linear transformations, projection, orthogonality, systems of linear equations, LU decomposition; eigenvalues and eigenvectors, etc.
  My responsibilities include leading tutorial classes, preparing homework solutions, grading homework and exams, and setting office hours.

Supervision Experience

Mentoring two PhD students whom I am collaborating with on projects related to **game theory, intrinsic formation control, and safety control of networked autonomous vehicles**. Collaborations have resulted in papers [J15] and [J5].

I designed the following projects and was the leading supervisor.

- Master degree thesis: From churn to Earn: Predictive models in Insurance, in KTH — *February 2025*
  Student name: Anna Backman
- Digital Futures Summer Research Internship Programme 2023: Nature-inspired dynamic control of the predator evader system, in KTH — *July 2023*
  Student name: Sirui Li (master level, now a PhD student at KTH)
  Our **collaborative paper** 'Nature-inspired dynamic control for pursuit-evasion of robots' [J8] has been revised for *Automatica* as a regular paper.
- Bachelor degree thesis: Optimal strategies for the pursuit-evasion problem of robots, in KTH — *Jan. 2025-present*
  Student name: Patrik Oksanen & Filip Niklasson
- Bachelor degree thesis: Optimal strategies for the pursuit-evasion problem of robots, in KTH — *Jan. 2025-present*
  Student name: Niklas Evans & Sondre Kristiansen
- Bachelor degree thesis: Pursuit-evasion problems of multi-agent systems in cluttered environments, in KTH — *May 2024*
  Student name: Mathias Bock Agerman & Jacob Ericsson
- Bachelor degree thesis: Potential mapping strategies for multiple-agent pursuit evasion problems, in KTH — *May 2024*
  Student name: Simon Sandström Nordin & Viktor Marin
- Bachelor degree thesis: A predictive analysis of customer churn, in KTH — *May 2023*
  The thesis is published in DiVA with id: diva2:1827745
  Student name: Eskils Olivia & Backman Anna

Academic Citizenship

- Associate Editor for the 19th IEEE International Conference on Control & Automation (IEEE ICCA), 2025
- Member of the International Program Committee of the IEEE 18th International Conference on Control & Automation, 2024
- Member of the International Program Committee of the IEEE 17th International Conference on Control & Automation, 2022
- Editor of the special issue 'New Trends in Control of Autonomous Systems' on Autonomous Intelligent Systems
- I am a reviewer of many top-tier journals and conferences, including IEEE Transactions on Automatic Control, Automatica, Journal of the Frank Institute, IEEE Transactions on Cognitive and Developmental Systems, IEEE Transactions on Control of Network Systems, IEEE Transactions on Industrial Informatics, International Journal of Robust and Nonlinear Control, Chinese Journal of Aeronautics, International Journal of Control, Nonlinear Dynamics, Unmanned Systems, Autonomous Intelligent Systems, IEEE Conference on Decision and Control, IFAC World Congress, American Control Conference, Chinese Control Conference.

Presentations

Invited presentations:

- Technical University of Darmstadt (Prof. Roderich Groß, Department of Computer Science), 'Distributed non-cooperative control problem of multi-agent systems', August 2025

- The University of Waterloo (Prof. Michael Fisher, Department of Electrical and Computer Engineering), 'Optimal pursuit-evasion solutions for multi-agent systems', March 2025
- Tianjin University (Faculty of Engineering), 'Distributed cooperative control for multi-agent systems', September 2024, Tianjin, China
- Digital Futures, 'Modelling and control for pursuit-evasion of robots', August 2024, Stockholm
- National University of Singapore (Prof. Lihua Xie, School of Electrical Engineering), 'Distributed optimal control for multi-agent systems', December 2023, Singapore

On-site presentations:

- The 26th International Symposium on Mathematical Theory of Networks and Systems
- The 62nd IEEE Conference on Decision and Control in December 2023
- The 40th Chinese Control Conference in July 2021

Online presentations (due to Covid) at

- The 17th International Conference on Control & Automation in June 2022
- The 16th International Conference on Control & Automation in October 2020
- The 2020 IFAC World Congress in July 2020

Collaborations

New York University (Prof. Zhongping Jiang), Texas Tech University (Prof. Bijoy Kumar), KTH (Prof. Karl Henrik Johansson, Prof. Dimos V. Dimarogonas, Prof. Xiaoming Hu, Prof. Bo Wahlberg, Prof. Giuseppe Belgioioso), University of Groningen (Prof. Ming Cao), CUHK (Prof. Ben M. Chen, Prof. Yunhui Liu), Westlake University (Prof. Shiyu Zhao), Peking University (Prof. Zhiyong Sun)

Professional References

- Prof. Ben M. Chen (bmchen@cuhk.edu.hk), IEEE Fellow, Chinese University of Hong Kong
- Prof. Xiaoming Hu (hu@kth.se), Department of Mathematics, KTH Royal Institute of Technology
- Prof. Bo Wahlberg (bo@kth.se), IEEE Fellow, Division of Decision and Control Systems, KTH
- Prof. Bijoy Kumar (bijoy.ghosh@ttu.edu), IEEE Life Fellow, Department of Mathematics and Statistics, Texas Tech University, USA
- Prof. Zhongping Jiang (zjiang@nyu.edu), IEEE Fellow, Tandon School of Engineering, New York University, USA